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CTD OBSERVATIONS OF THE ARCTIC OCEAN HALOCLINE

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LONG TERM GOALS

We seek to identify the extent, morphology, and genesis of the Arctic Ocean halocline as well as surface and Atlantic Water layers.

OBJECTIVES

The objective is to map the extent of various halocline types and compare their properties with older data and with climatologies.

APPROACH

We have used CTD data taken by the US nuclear submarine Cavalla during the spring of 1995. Three types of CTD observations were used: (i) high-frequency underway CTD measurements recorded by an instrument fixed in the ship's sail, (ii) expendable CTD measurements recorded by an experimental XCTD developed by Sippican and launched through the torpedo tubes, and (iii) traditional through-ice CTD profiles obtained after the submarine surfaced through the ice.

ACCOMPLISHMENTS

We have completed the intercalibration of CTD observations taken by the three methods described in "Approach."

SCIENTIFIC RESULTS

A comparison of our observations with data taken in 1993 and 1991 reveals significant trends and frontal shifts through the decade of the 1990's. A comparison with climatology reveals that these changes had just started in 1991, and supports the idea proposed by others of an abrupt transition in the late 1980's. In particular, we have examined changes in the so-called "Cold Halocline Layer" (CHL), a layer of cold, salty water that lies under the surface layer and above the Atlantic Layer in the Arctic Ocean. The climatological significance of the CHL is that it insulates the surface waters (and thus the sea ice) from the relatively warm Atlantic Layer that lies at several hundred meters depth. Without a CHL, heat is available for mixing into the surface layer, and ice melting is the result. An example is the Antarctic sea ice pack, where a CHL is absent and heat from the Atlantic Layer rises up to the surface freely. The result is much thinner ice (less than a meter thick) than in the Arctic Ocean.

Our results show that the area of the deep Arctic Ocean covered by a true CHL in 1995 was actually quite small: essentially, only the Makarov Basin. Comparison with previous data indicate that the Amundsen Basin used to have a CHL at least through 1991; by 1995 it had disappeared from this basin. The result is an unprecedented salinification of surface waters in the Eurasian Basin. We say “unprecedented” because our comparison with a new Russian-American climatology reveals that in 1995 these waters were saltier than the maximum salinities ever recorded in the 40 year history of the climatology.

A paper has been submitted to the Journal of Geophysical Research on this subject (Steele and Boyd, 1997).

IMPACT FOR SCIENCE

Changes in the water mass structure of the upper Arctic Ocean have recently been documented by others. Our study emphasizes that these changes may influence the overlying sea ice cover by removing the insulating CHL and thereby enhancing sea ice melting. This may provide motivation for an initiative to monitor these large-scale changes in the Arctic Ocean.

TRANSITIONS

None.

RELATED PROJECTS

None.

REFERENCES

Steele, M. and T. Boyd, Retreat of the Cold Halocline Layer in the Arctic Ocean, submitted to *J. Geophys. Res*., 1997.

Steele, M., J. Zhang, D. Rothrock, and H. Stern, The force balance of sea ice in a numerical model of the Arctic Ocean, *J. Geophys. Res*., in press, 1997.